NONSTANDARD FIXED BRIDGE

CHAPTER 10

A bridge is a structure that carries a roadway over a depression or an obstacle. Bridges may be classified in different ways. Two general classifications, for example, are highway and railroad bridges. One of the bridges most commonly found in the TO is the nonstandard fixed bridge. This chapter discusses the construction of both the substructure and the superstructure of this important military bridge.

BRIDGE CLASSIFICATION

A bridge completely supported by its two end supports (abutments) is called a *single-span* bridge. A bridge having one or more intermediate supports between the abutments is a *multispan* bridge. All supports of a fixed bridge transmit the load directly to the ground.

A nonstandard fixed highway bridge (Figure 10-1) is a semipermanent bridge constructed from local materials or Class IV materials drawn from a depot. It differs from standard bridges, which are prefabricated bridges assembled at the site. The most common nonstandard fixed highway bridges are the simple, stringer-type (the stringers being logs) and those made of structural grade timber or structural steel.

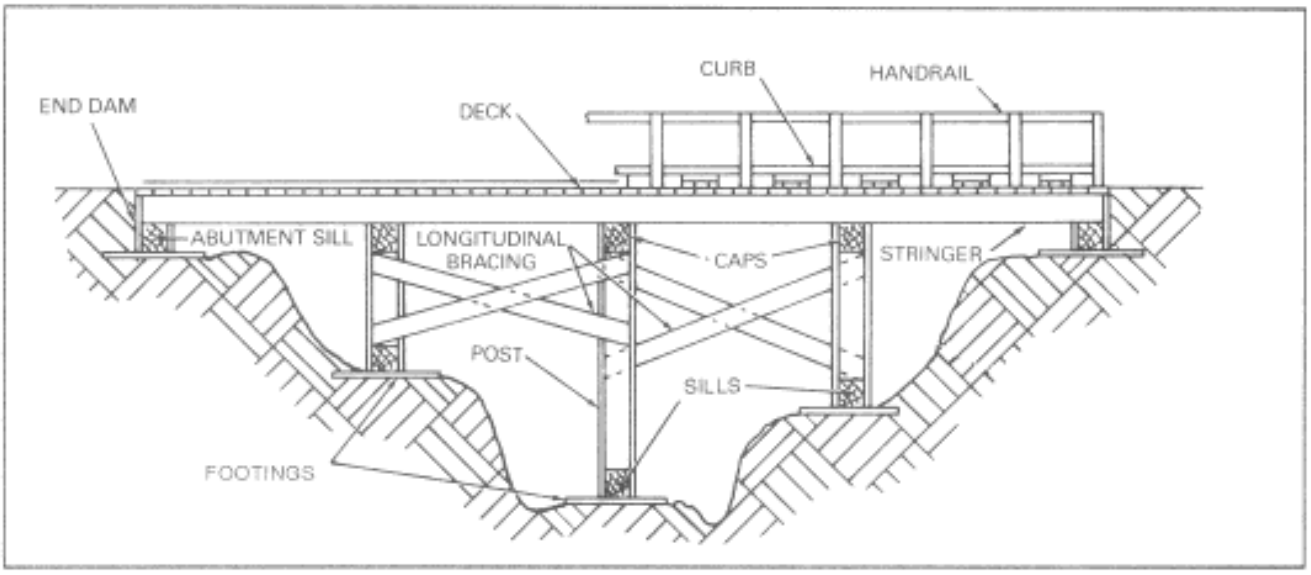

Figure 10-1. Nonstandard fixed highway bridge

A military bridge has two principal parts: the lower part (substructure) and the upper part (superstructure).

SUBSTRUCTURE

The substructure of a bridge supports the superstructure. The substructure consists of

ABUTMENTS

There are two types of end supports or abutments: *footing* and *pile.*

Footing

The footing abutment consists of—

- *Footings.* Footings transmit the load to the ground. They receive the load from the sill and distribute it over a sufficient area to keep the support from sinking into the ground.
- *Sill.* The abutment sill (Figure 10-2) receives the load from the stringers and transmits it to the footings.
- *End dam*. The end dam (or *bulkhead)* is a wall of planks at the end of the bridge to keep the approach road backfill from caving in between the stringers.

Pile

The pile abutment (Figure 10-3) has three main parts:

- Piles driven into the ground, transmitting the load to the soil.
- A cap on top of the piles to receive the load from the stringers.
- Sheeting fastened to the piles to hold the backfill in place.

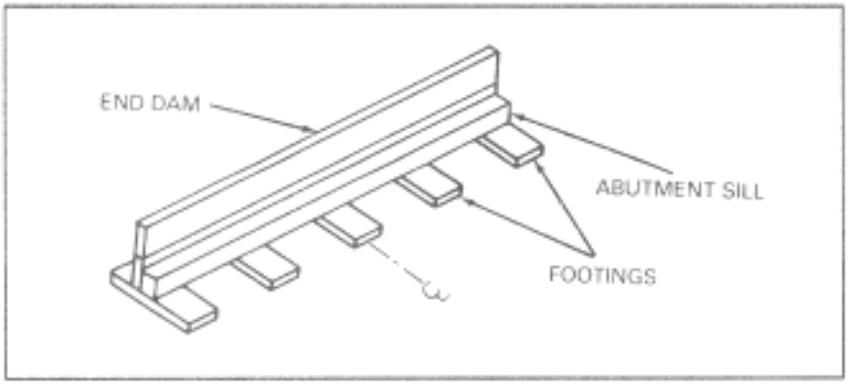

Figure 10-2. Timber sill abutment

INTERMEDIATE SUPPORTS

The following are some of the different types of intermediate supports.

Pile Bent

The pile bent (Figure 10-4) consists of the bent cap, which provides a bearing surface for the stringers and transmits the load to the piles; and the piles, which transmit the load to the soil.

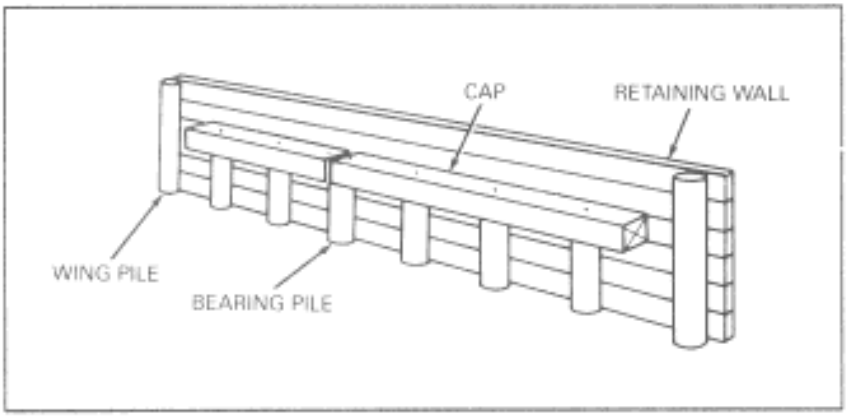

Figure 10-3. Pile abutment and retaining wall

The support for the loads may come either from column action, when the tip of the pile bears on a firm stratum such as rock or hard clay, or from friction between the pile and the soil into which it is driven. In both cases, earth pressure must give some lateral support; transverse bracing is also often used for this purpose.

The pile bent is used for highway bridges only. It is designed to carry both vertical and lateral loads and can be used for spans of up to 50 feet. Its ground-to-ground height is a function of its unbraced length.

Trestle Bent

The trestle bent (Figure 10-4) is like the pile bent except that posts take the place of piles. The posts transmit the load from the cap to the sill, the sill transmits the load to the footings, and the footings transmit the load to the soil. The length of the posts varies according to the height of the bridge above the gap to be spanned. Transverse bracing like that used with the pile bent is provided.

The trestle bent is used for highway bridges only; however, unlike the pile bent, it is designed to carry vertical loads only. It can be used for spans of up to 30 feet and for ground-to-grade heights of up to 12 feet.

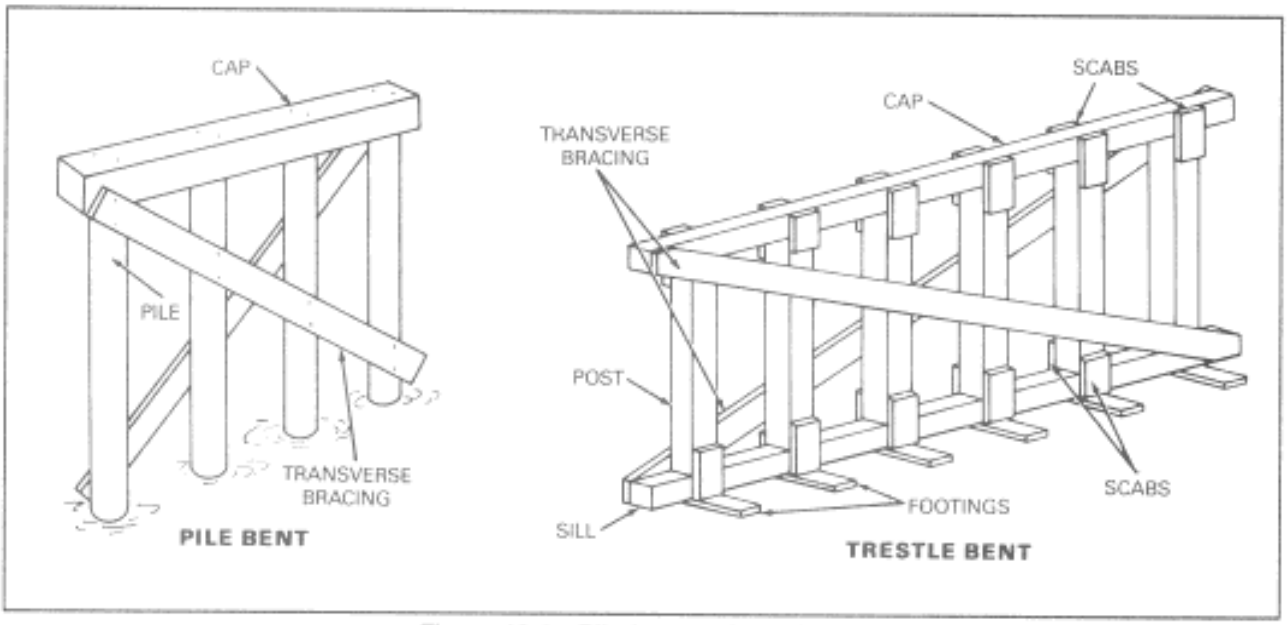

Figure 10-4. Pile bent and trestle bent

Pile-Bent Pier

The pile-bent pier (Figure 10-5, page 10-4) is composed of two or more pile bents with a common cap. The cap transmits the load to the corbels (short, stringer-like members) that, in turn, transmit the load to the individual bent caps and then to the piles and to the soil. Piers usually have cross bracing which ties the bents together, giving them longitudinal rigidity.

The use of multiple bents gives the pile-bent pier great strength. As a result, the pile-bent

pier can be used for both highway and railroad bridges. It will carry both vertical and lateral loads, can be used for spans of up to 200 feet, and its ground-to-grade height is governed by its unbraced length.

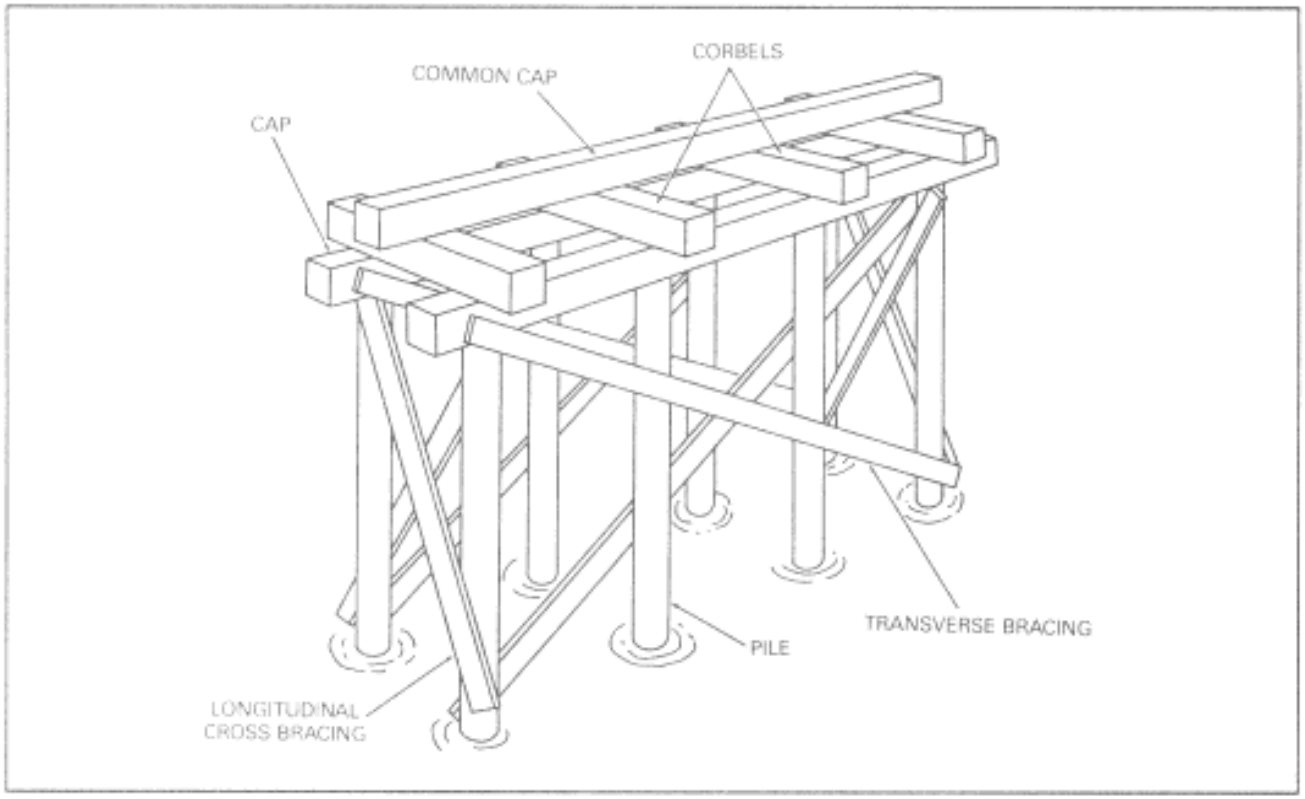

Figure 10-5. Pile-bent pier

Trestle-Bent Pier

The trestle-bent pier (timber-trestle pier) (Figure 10-6, page 10-4) is the same as the pile-bent pier, except that it has sills and footings which transmit the load to the soil.

The trestle-bent pier is used for highway bridges only. It is designed to carry vertical loads only and can be used for spans of up to 60 feet and for ground-to-grade heights of up to 18 feet.

Crib Pier

The crib pier (Figure 10-7, page 10-5) is quite different from pile and trestle piers. It is composed of logs or dimensioned timber fitted together in log-cabin style and is usually filled with rock or other stable fill material. The crib pier should be made so that it needs no exterior bracing. As an expedient, crib piers may be built to the height of the stringers, eliminating the trestle bents.

The crib pier is used for highway bridges only. It is for vertical loads only and can be used for a span of up to 50 feet and a ground-to-grade height of up to 12 feet.

BRACING

Bracing consists of longitudinal bracing, transverse bracing, and diaphragms.

Longitudinal bracing (Figure 10-8) is used to stabilize the bridge centerline.

Transverse bracing (Figure 10-8) provides stability at right angles to the centerline. It is sometimes called sway or lateral bracing.

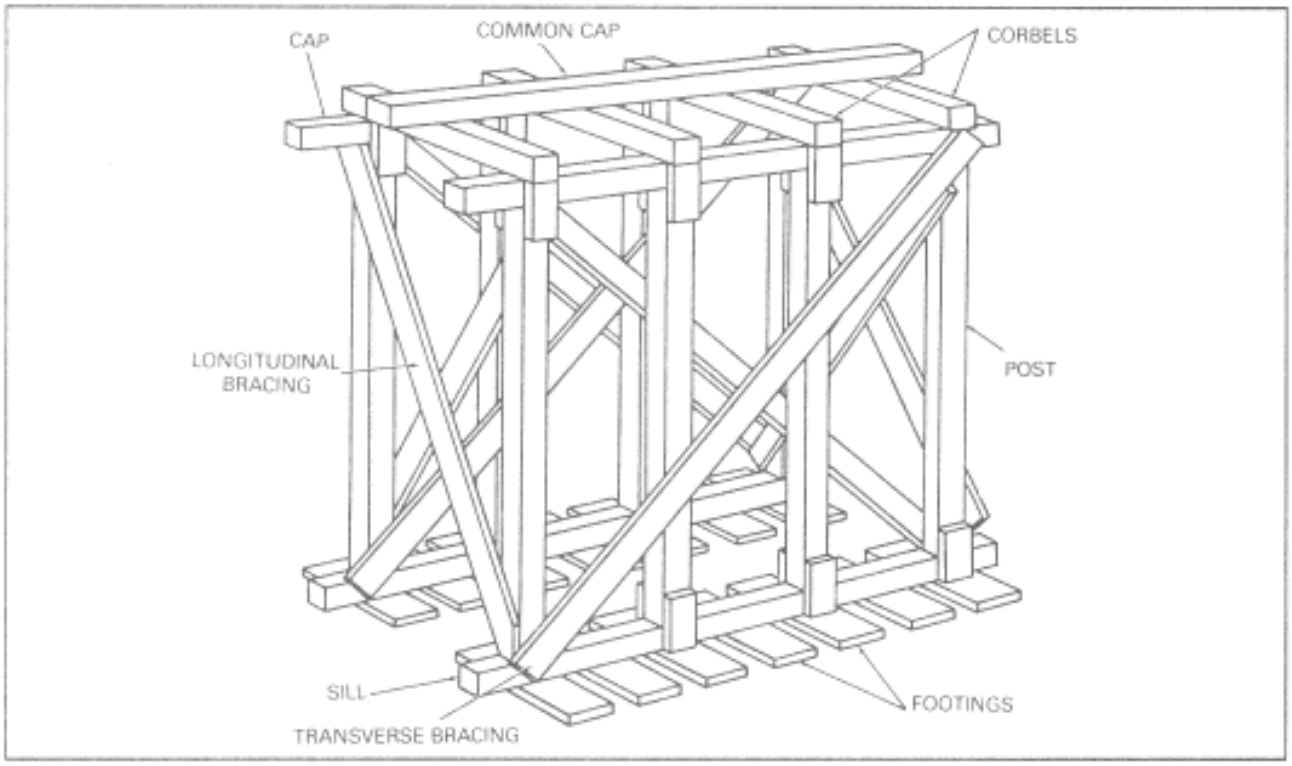

Figure 10-6. Trestle-bent pier

Diaphragms are braces between stringers to prevent them from deflecting laterally (buckling) under load. In spacing these diaphragms, the ratio of distance between diaphragms to the width of the top of stringer (L/b ratio) should not exceed 30 for timber.

L = distance between diaphragms
b = width of top of stringer

Example. If the stringer is 6 inches wide—

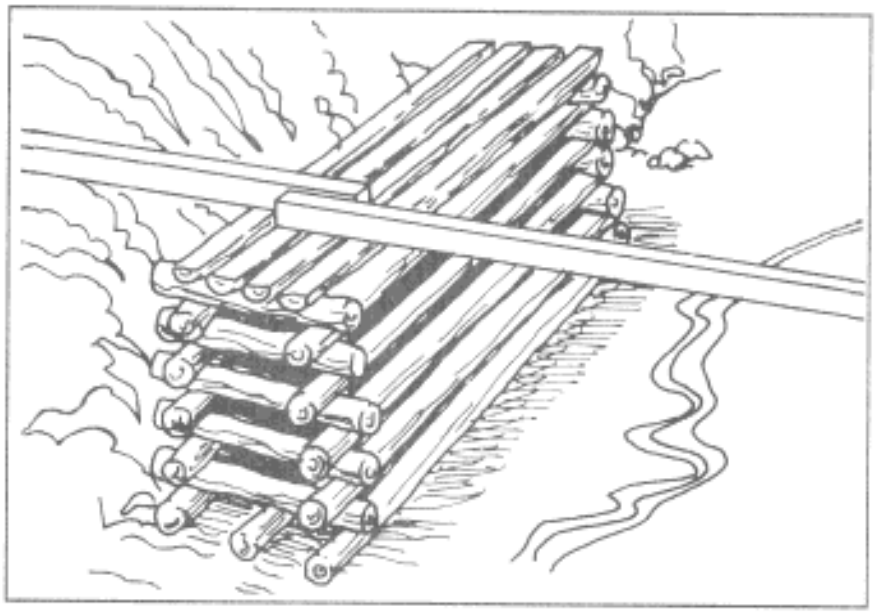

Figure 10-7. Crib pier

L = 30 *L* = 180 *inches* (15 *feet)*

In this example, diaphragms should be used every 15 feet between stringers 6 inches wide.

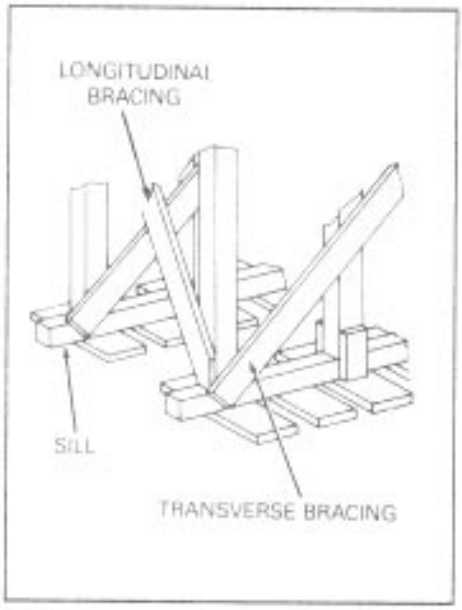

Figure 10-8. Bracing

CONSTRUCTION PROCEDURES

The following paragraphs contain construction procedures for a trestle-bent bridge. This includes laying out the centerline and constructing abutments, retaining walls, and trestle bents.

Layout of Centerline

The first task in constructing a trestle-bent bridge is laying out the centerline (Figure 10-9, page 10-6):

Step 1. Stretch a line or tape representing the centerline across the stream or ravine.

Step 2. Attach the line to stakes driven into the ground at least 15 feet behind the proposed location of the abutment sills. For defiles wider than 100 feet, use intermediate stakes as needed to prevent sag.

Step 3. Place the line at the level of the intended top of the flooring or at some known distance above or below it.

Construction of Abutments

Saving time in abutment construction is especially important on short bridges. Abutment and approach preparation often requires as much time as the rest of the bridge. Use the simplest abutment possible; often a timber sill with timber footings is adequate (page 10-2).

The end dam is installed after the stringers and planks.

After the centerline is fixed—

Step 1. Place the abutment sill at approximately its correct location under the tape. See that it is at right angles to the centerline by using a line from the centerline stake 15 feet behind the sill to each end of the sill. Both distances must be the same.

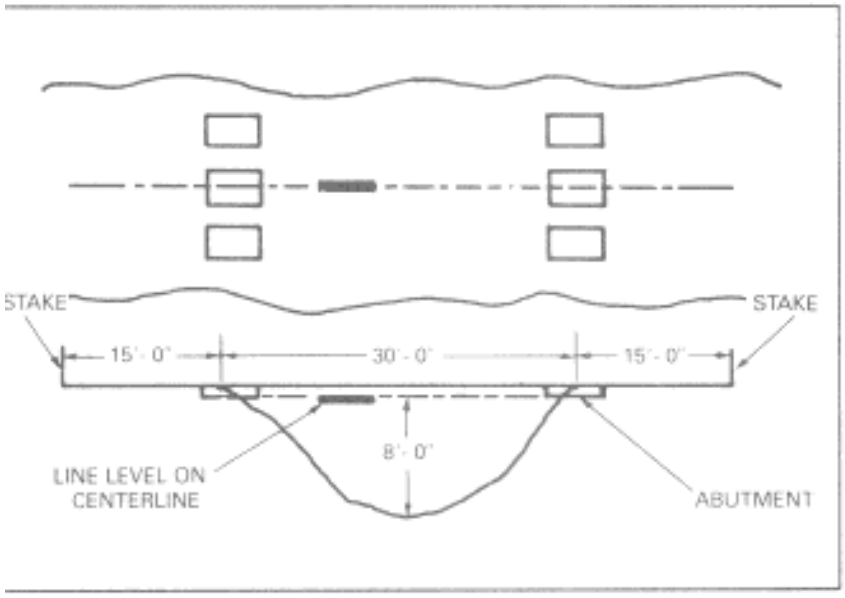

Figure 10-9. Laying out a centerline

Step 2. Once the sill is properly

located, mark its position and remove it to construct the foundation.

- Remove the earth as needed to provide a level surface for footings. The sill must be level and supported equally by each footing when installed. Make sure that the surface supporting the footings is about 2 inches higher than its final position to allow for settling. Do not dig too deeply. If this is done by mistake, do not backfill with earth. Instead, raise the level with planking.
- Place the two outside footings so that their outer edges are under the ends of the sill. Place the long dimension of the footings parallel to the bridge centerline.
- Place the remaining footings, equally spaced, between and in line with the outside footings.
- Place the sill on the footing centerline so that the load is in the middle of each footing. Place the sill with the largest dimension vertical.
- Provide for drainage of the abutment area.

Construction of Retaining Walls

Retaining walls and revetments, when needed, are part of the abutment construction. The simplest type of retaining wall is built of planks or logs supported by piles or posts. (Figure 10-10 shows an abutment and retaining wall; Figure 10-11 shows retaining-wall details.)

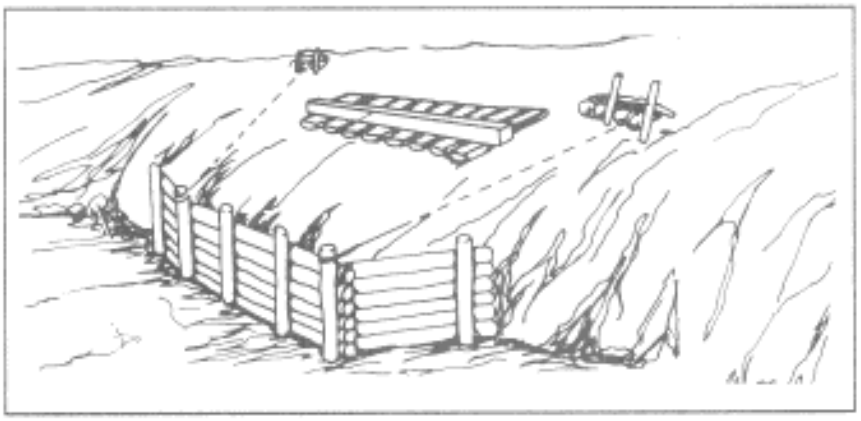

Figure 10-10. Abutment and retaining wall

- Use wing walls to prevent the earth from washing out behind the retaining wall.
- Drive piles or posts 4 feet into the ground.
- Fasten anchor cables from the top of the piles to a deadman behind the retaining wall or to the wing-wall end. These deadmen and anchors can be eliminated if two or three rows of piles, driven as far as they will go, are used.
- For long spans and heavy loads, the abutment and retaining wall are often constructed as a unit. This may also be necessary where steep banks and poor soil conditions exist.

Construction of Trestle Bents

After the position of the near-shore abutment sill is established, locate the position of the first trestle bent:

Step 1. Measure the length of the first span from the abutment sill along the centerline (Figure 10-12).

Step 2. Drive a small stake under the centerline where the center of the trestle bent is to be. Use a plumb bob if necessary.

Step 3. Continue this procedure until all trestle bents and the far-shore abutment sill are located.

Step 4. Excavate and place footings under the trestle bent the same as for the abutment (page 10-

5). Outside footings under the trestle sill are centered under the outside posts of the bent.

- Measure the vertical distance from the centerline down to the top of the footings.
- If the centerline was placed at the intended top of the flooring, this distance minus the thickness of the tread, deck, and stringers gives the height of the trestle bent.
- If steel stringers are to be used, allow also for the thickness of the nailing strips.

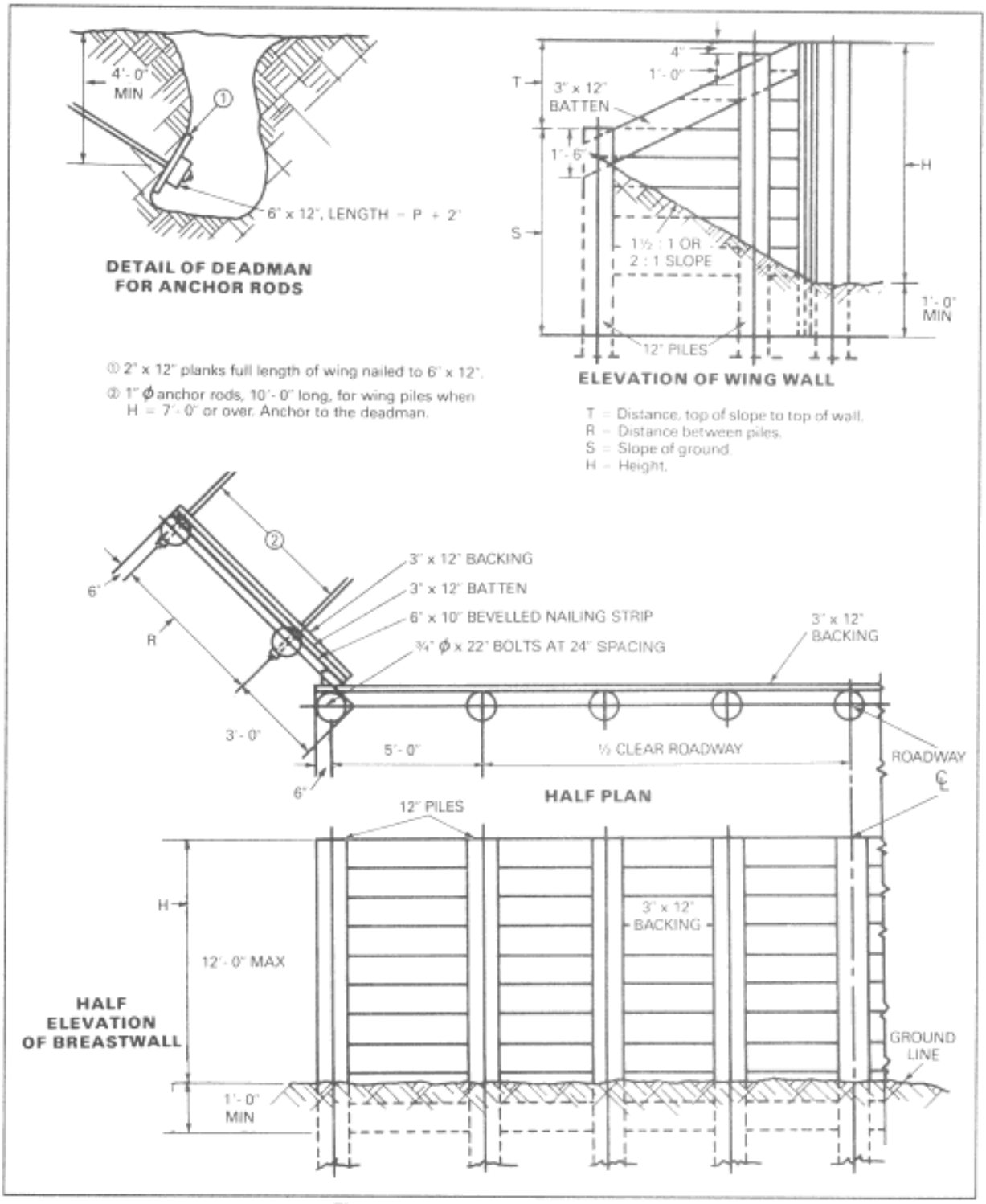

Figure 10-11. Retaining-wall details

Step 5. To obtain the correct height of the trestle-bent posts, subtract the thickness of the cap and sill from the height of the trestle bent.

Additional Construction Procedures

There are some additional procedures that should be followed when constructing a substructure.

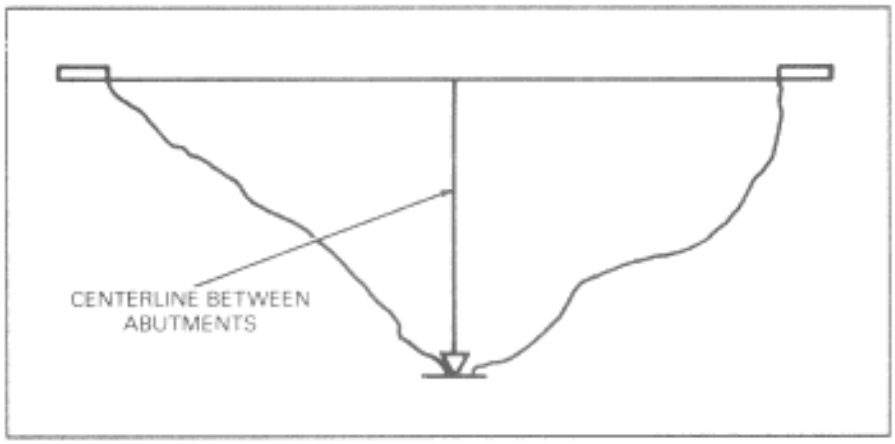

Figure 10-12. Determining trestle-bent height

- Make the length of the cap and sill equal to the roadway width plus 2 feet.
- Center the outside posts under the roadway edges 1 foot from the ends of the cap and sill. Space other posts evenly between the outside posts.
- Use driftpins or bolts to fasten the sill and cap to the posts. Use scabbing instead of driftpins for fast erection.
- Nail transverse bracing across both sides of the bent. Usually 3- x 12-inch planks are used. Fasten the bracing to each post that it passes over. Cut the bracing so that the ends extend beyond where they are nailed, to prevent splitting.
- Put the bent into position, using a plumb bob to ensure that it is straight. Hold it in place with temporary braces nailed to stakes driven into the ground. Use these temporary braces until the permanent longitudinal bracing can be nailed to the outside posts of adjacent trestle bents.

SUPERSTRUCTURE

The superstructure is the spanning structure consisting of stringers, flooring (decking and tread), and other features such as curbs, handrails, sidewalks, and end dams.

STRINGERS

When wood stringers are used, they are usually long enough to extend across the abutment sills and trestle caps on which they rest. Stringers of one span are lapped with those of the next span.

Placing Stringers

After the abutment and trestle bents are in place, the stringers are installed (Figure 10-13).

When stringers are lapped, place one outside stringer so that its inside face is under the inside face of one curb. Place the other outside stringer so that its outside face is under the inside face of the other curb. Stringers can then be lapped with a similar spacing on the next span. The remaining stringers are usually spaced evenly between the outside

stringers. On some narrow one-lane bridges, stringers may be grouped closer together under the vehicle tracks.

When stringers are butted, or continuous across the span, place the outside faces of both outside stringers under the inside faces of the curbs.

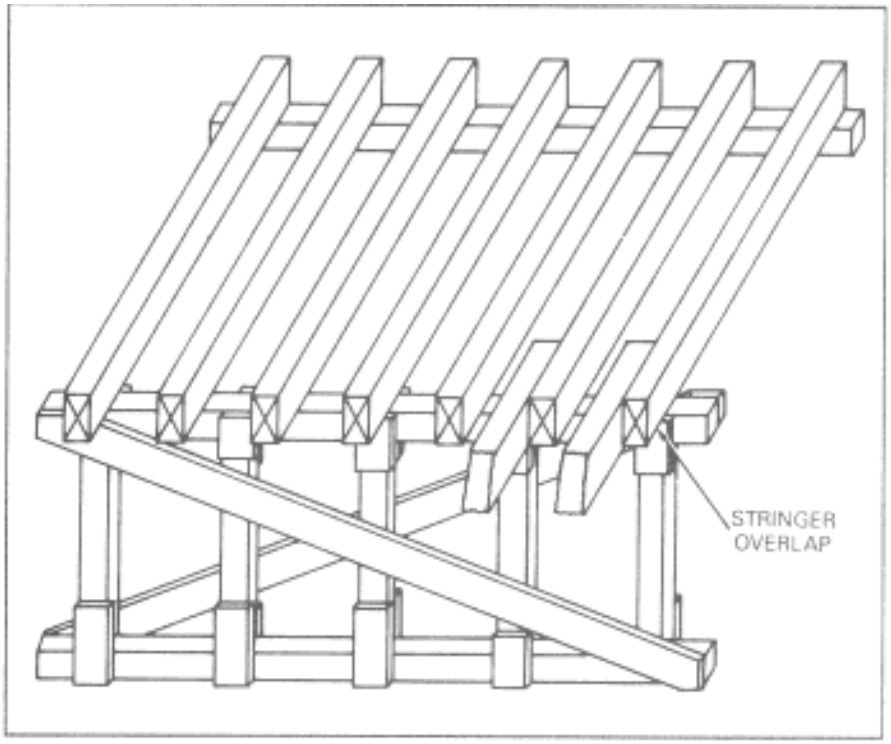

Figure 10-13. Stringer placement

Fastening Stringers

Fasten stringers (Figure 10-14) as follows:

Wood Stringers. Fasten wood stringers by driving nails diagonally through the side of the stringer into the cap or by driftbolts. When using driftbolts, bore a hole, smaller in diameter and 3 inches shorter than the driftbolt, through the stringer and into the cap.

Steel Stringers. Fasten steel stringers by—

- Driving railroad spikes into the cap beside the flange.
- Driving 60d nails partially into the cap and bending them over the bottom flange.
- Driving nails or driftbolts through prebored holes in the bottom flange.

NOTE: When steel stringers are not fastened through their flanges, frequent inspection is necessary to be sure the stringers have not shifted. Fasten wood nail strips to the top flange of steel stringers to provide a means of fastening the flooring.

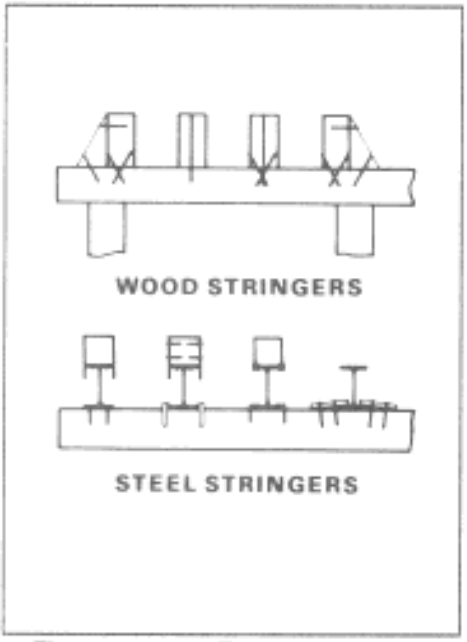

Figure 10-14. Fastening stringers

When a laminated deck (planks placed on edge) is to be installed, the planks may be fastened to steel stringers either by using metal clips provided for the purpose or by driving nails partially into the deck and bending them around the stringer flange (Figure 10-15).

FLOORING

The flooring system of a typical timber-stringer trestle bridge consists of two main parts: the decking and the

tread.

Decking

The decking is the part of the structure that is laid on the stringers to form the roadway across the trestle bridge. Decking may be laminated or solid plank.

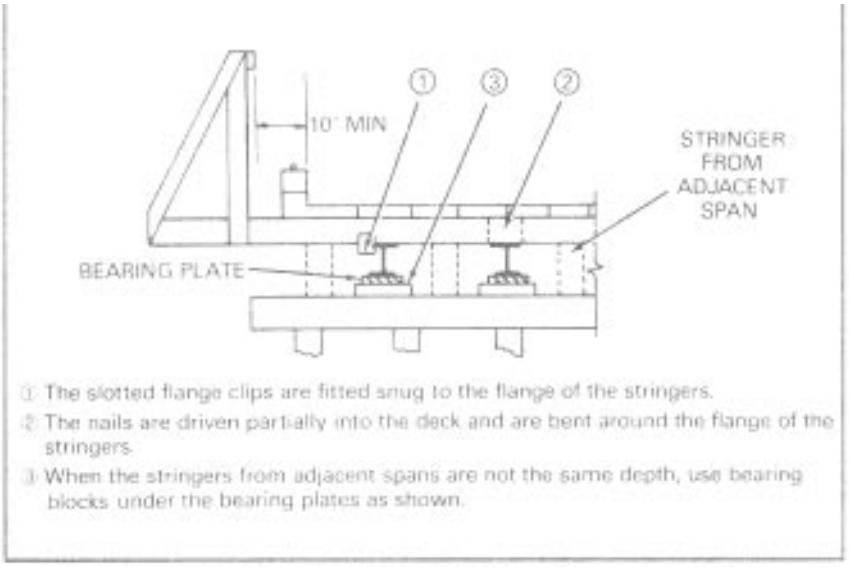

Figure 10-15. Open laminated deck, sectional view

Laminated. Laminated decks may be solid or open with uniform spacing between members.

- For an *open laminated* deck (Figure 10-16) where the planks are long enough to reach completely across the width, use two spacing blocks between laminations. Place spacers on the stringer nearest one-third the length of the lamination. Where the laminations are not long enough (usually true for two-lane bridges), lap the laminations on a **central** stringer. Put a spacer block at each outside stringer.
- For a *solid laminated* deck, place laminations solidly against one another.

Solid Plank. For a solid-plank deck (Figure 10-17), lay planks horizontally, at right angles to the stringers. Leave a 1/4-inch space between planks to allow for swelling when wet.

Extend the decking about 2 feet at approximately 5-foot intervals to support the handrail posts (Figure 10-18, page 10-12).

Tread

The tread consists of planks placed over the decking and between (but not under) the curbs. The planks are usually 2 or 3 inches thick, of varying lengths, and are laid parallel to the direction of traffic. On one-lane bridges, the tread is limited to the path of the wheels or track. Two-lane bridges are fully covered with tread. (Figure 10-19, page 10-12 shows tread placement.)

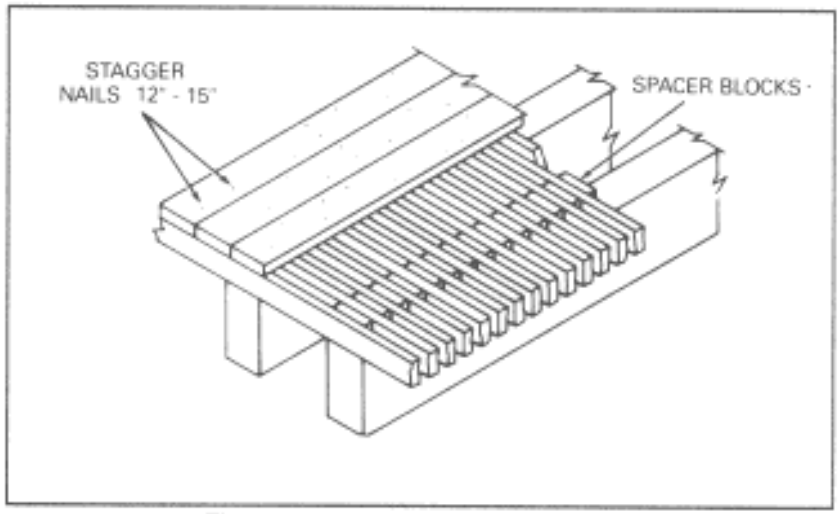

Figure 10-16. Open laminated deck

CURBS

A curb system on a timber-trestle bridge is used to guide traffic on

the bridge. When assorted sizes of lumber are available, make curbs of 6- x 6-inch timber supported on 6- x 12- x 30-inch curb risers, spaced on about 5-foot centers. The curb is usually bolted to the decking with 1/2-inch bolts, two per curb riser.

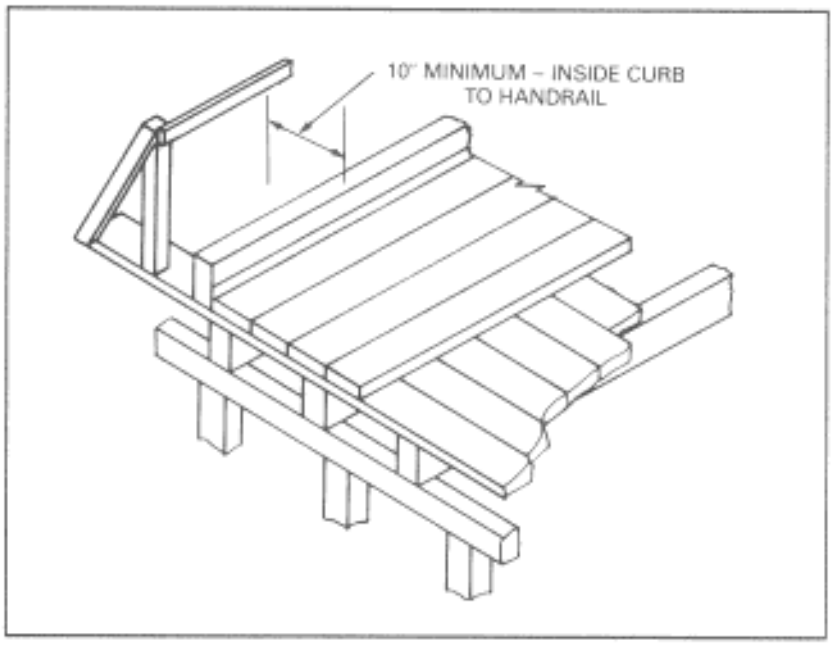

Figure 10-17. Solid-plank deck

HANDRAILS

Handrails (Figure 10-20, page 10-12) mark the bridge route and provide safety for pedestrians crossing the bridge. Make handrails of 2- x 4-inch or larger material, if available. Over a laminated deck, make handrail posts and knee braces of the same material as the deck so that they can be fastened snugly between the laminations, which are extended to receive them.

For solid-plank decks, toenail 4 x 4 posts, or two 2 x 4s nailed together, to the extended planks. Make the posts 42 inches high and space them on 5-foot centers. Place the posts so that the distance from the inside face of the curb to the inside face of the handrail is at least 10 inches.

SIDEWALKS

If sidewalks are necessary, form them by extending the decking an additional 36 inches. Place stiffening members underneath the outside edge. Support them with braces attached to the stringers, where necessary.

END DAM

The end dam is the wall that withstands the earth pressure of the abutment of a bridge (see Figure 10-1, page 10-1). After the stringers and flooring are in place, construct an end dam of flooring planks across the end of the stringers. The end dam should extend across the roadway from the top of the footing to the top of the tread. After placement of the end dam, complete the approach up to the top of the bridge deck. Post the traffic-control and classification signs. The bridge is now ready for traffic.

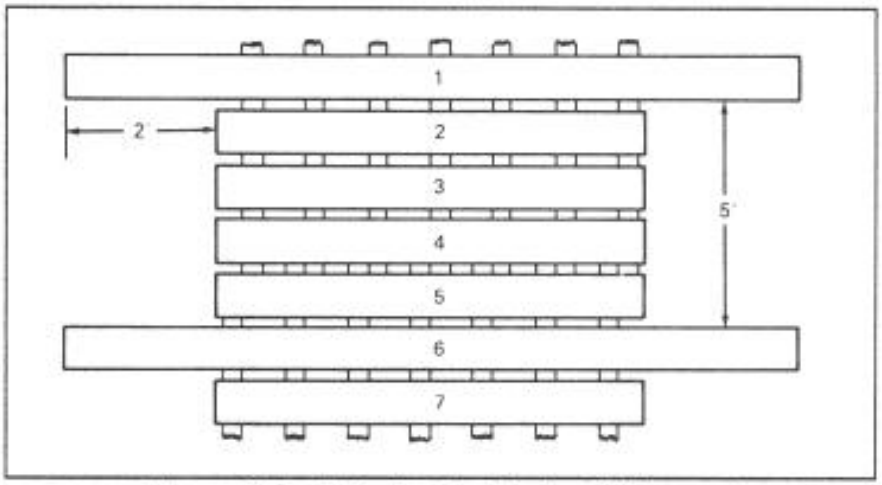

Figure 10-18. Extended deck for handrail support

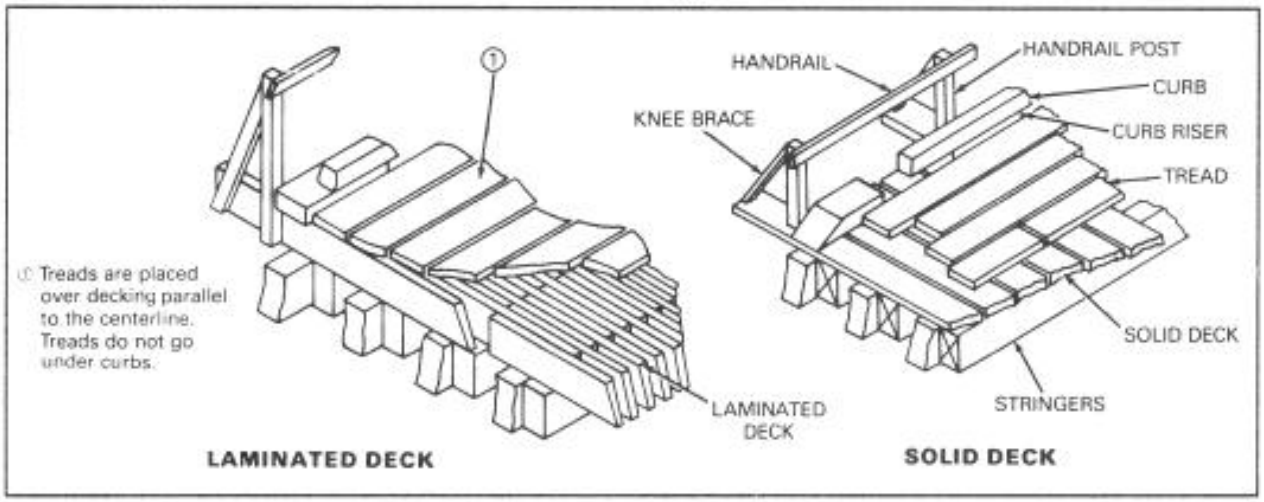

Figure 10-19. Tread placement

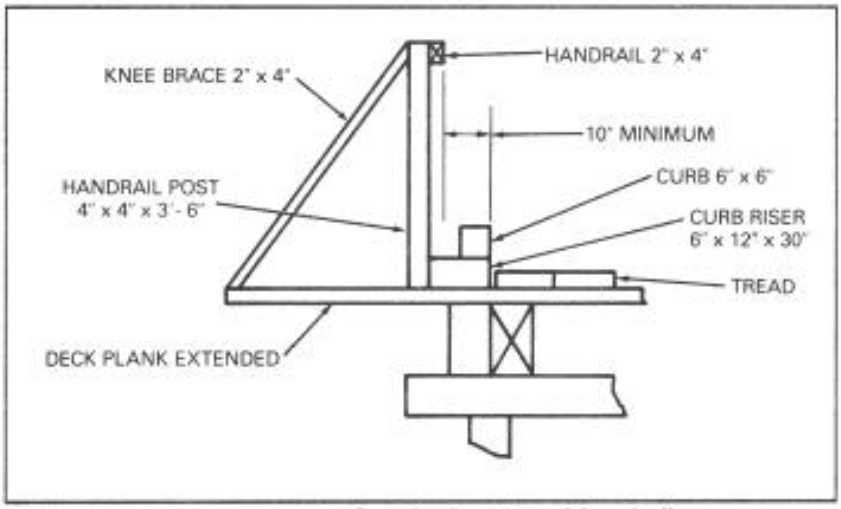

Figure 10-20. Standard curb and handrail